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Economics of food safety practices among cassava processors in northcentral Nigeria

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Food safety is a critical issue and a growing public health concern. Cassava being one of the staple foods widely consumed by the majority of households in Africa involves several processes. Assessment of the safety practices adopted by the processors is an important approach to enhancing consumers' food safety and avoiding food poisoning. Thus, this research assessed the economics of food safety practices adopted by cassava processors. Data collected from randomly selected 120 cassava processors were analysed using descriptive statistics, costs, and returns analysis, and the Likert-type ranking method. The results show that the majority of the processors were female with an average age of 46.6 years. They sourced food safety processing information through radio, public sanitary officers, extension agents, television, and the internet. All the processors always practised the peeling, washing, fermenting, grating, and pressing of cassava as safety practices to remove hydrogen cyanide. About 95% always applied safety practices in sifting and frying while 74% stored their products. The motivating factors of food safety practices adopted by cassava processors were demand-driven, to make profits, health concerns of their consumers, improve efficiency and reduce wastage. The cassava processors had a net profit of N81, 052.33 (USD 195.75), a return on capital invested of 0.62, an operating ratio of 0.61, and a benefit-cost ratio of 1.52 per two tonnes of cassava processed. Thus, food safety practice in cassava processing was profitable. Inadequate finance, high cost of cassava tubers, time-consuming, poor access to clean water, and lack of modern processing facilities were major constraints to food safety practices in cassava processing. These call for government and NGO support to promote food safety practices through proper education of the processors on food safety practices, provision of modern processing facilities, and credit facilities.

1. Introduction

Food poison is a serious concern, especially in developing countries where local food processors did not use modern facilities to process food which may lead to food-borne diseases. Food-borne disease due to poor food processing contributes significantly to the huge burden of ill-health and death of people (Thomas & Philips, 2015; World Health Organization, 2015). Four hundred and twenty deaths are recorded globally as a result of food-borne illness (World Health Organization, 2015). There is evidence of unsafe food practices among food producers, handlers in the food chain system, caterers, and processors. Therefore, food-borne illnesses may result from eating contaminated foods containing chemical or biological poisons

and pathogenic microorganisms arising from careless or poor food handling practices at any stage in the food supply chain (Federal Ministry of Health, 2014).

Food safety practices involve measures taken to protect human health from harm arising from consuming food that is not well prepared. Safe foods are food prepared, produced, processed, and stored in such a way that their consumption will not affect consumers negatively. Unsafe foods are contaminated food with a chemical, microbiological or physical hazard which can affect human and animal health negatively (Focker & van der Fels-Klerx, 2020). Due to the vital role food safety plays in human health, governments, and local and international agencies play surveillance and regulatory roles to enhance food safety globally. The United Nations, Food and Agriculture Organization, the United States Department of Agriculture Food Safety Inspection Service, and the Food and Drug Administration assists to achieve food safety at the global level. Nationally (Nigeria), the National Agency for Food and Drugs Administration and Control (NAFDAC), the Federal Ministry of Health, Standards Organization of Nigeria (SON), and the Federal Ministry of Agriculture and Rural Development ensure food safety in Nigeria. Although, most of the food safety interventions in Nigeria were targeted at branded food products. Only branded products request for and issued NAFDAC registration number and SON accreditation. Whereas, the local producers of food such as garri (cassava flakes) which is a common food in Nigeria, especially among the low-income households which are the majority of the population, find it difficult to get a NAFDAC registration number. This posed a serious threat to the consumers as they are not sure of the safety of the food. Garri is, however, the most important product of cassava in Nigeria and some other African countries.

Cassava (Manihot species) belongs to the family Euphorbiaceae. It is widely grown in Nigeria, especially in the southern and middle belts part of Nigeria. In Africa, cassava is the second most-consumed staple food crop after maize (Alamu et al., 2019). Despite the great importance of cassava in achieving food security, it contains a poisonous substance known as hydrogen cyanide or simply called cyanide. Because of the presence of hydrogen cyanide in fresh cassava tubers, it requires proper and safe processing. Poor processing of cassava results in health challenges and may lead to the death of people. This is because poor food processing methods and contamination of food during pick-up and preservation are major sources of food-borne diseases. Proper processing of cassava will reduce the hydrogen cyanide in cassava. Thus, it is vital to understand the safety practice of cassava processors and if it is economical.

Studies have assessed the processing of cassava (e.g., Adeoye et al., 2019; Alamu et al., 2019; Thomas & Philips, 2015). Adeoye et al. (2019) assessed garri production safety practices among cassava processors in Oyo state Nigeria. Alamu et al. (2019) evaluated household-level cassava processing and utilization in Zambia. Thomas and Philips (2015) investigated cassava processing food safety practices in Oyo state, Nigeria. Apart from the fact that none of the studies was conducted in northcentral Nigeria, none of the studies investigated how economical the food safety practices are. This study, therefore, examined the economics of food safety practices among cassava processors in northcentral Nigeria. To have an extensive study on the assessment of food safety in cassava processing, the study specifically (1) examined the motivating factors of the use of safety practices, (2) assessed cassava processors' knowledge of safety practices, (3) identified the source of food safety information, (4) examined various food safety practices adopted in cassava processing, (5) investigated the profitability of food safety practices, (6) assessed the perceptions of cassava processors on the various risks involved in processing cassava, and (7) identified the constraints to cassava processing food safety practices. This would provide relevant information by helping to identify various ways by which cassava processors go about the safe processing of their cassava produce. It will also help in understanding the problem faced by the processor while trying to make the product safe and healthy enough for human consumption.

2. Methodology

2.1 Study area

This research work was carried out in Kwara State, North Central, Nigeria. Kwara State was purposively selected as the study area of this research work because of its considerable socio-economic heterogeneity, location, and a large amount of the total population (about 70%) was engaged in farming and allied

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activities such as cassava processing. Considering the location, it is the gateway between the southern and northern regions. The people of the state comprise Yoruba, Fulani, Nupe, and Baruba. Kwara State is located between latitudes 80 30 'N and 80 50' N and longitude 4020'E and 4035'E. The state has four Agricultural Development Programme (ADP) zones and sixteen Local Government Areas (LGAs). Each LGA is divided into districts, which are made up of villages. The state shares an international border with the Republic of Benin and a national border with Oyo state in the west, Kogi state in the east, Ondo and Osun states in the south, and Niger state in the north.

2.2 Sampling procedure and sample size

This study employed a four-stage sampling technique to select the respondents. Two ADP zones (Zone C and Zone D) out of the four zones in Kwara state were purposively selected due to the predominant of cassava processors in the zones. Two LGAs were randomly selected from each of the ADP Zones making a total of four LGAs (Asa, Ilorin East, Ifelodun, and Offa). In the third stage, three communities were randomly selected from each of the LGAs, this gave a total of twelve rural communities. Afon, Eiyenkorin, and Laduba were selected from Asa LGA; Ile Apa, Oke Oyi, and Iporin were selected from Ilorin East LGA; Idofian, Jimba Oja, and Ore-ago were selected from Ifelodun LGA; Offa, Balogun and Shawo East were selected from Offa LGA. In the fourth stage which was the last stage of the sampling procedures, ten cassava processors were randomly selected from each community which gave a total of 120 cassava processors that were used for the study.

2.3 Data collection techniques

Primary data were collected using questionnaires that were administered to the cassava processors. The data collected during the field was on demographic data such as gender, age, marital status, household size, farming experience, income, and level of education. Data on food safety in cassava processing, constraints to food safety in cassava processing, safety practices used by cassava processors, and costs and returns associated with safety practices were collected.

2.4 Analytical techniques

The analytical tools that were employed to achieve the objectives of the study include descriptive statistics, costs and return analysis, and the Likert-type scale.

2.4.1 Descriptive statistics

Descriptive statistics such as frequency, percentages, and means were used to describe the demographic features of the cassava processors. The descriptive analysis was also used to identify the safety practices adopted by cassava processors in the study area to guarantee consumer safety. The source of information on cassava processing, the perceptions of cassava processors on the various risks involved, the motivating factors of the use of safety practices, and cassava processors' knowledge of safety practices were also examined using descriptive statistics.

2.4.2 Cost and return analysis

Gross margin analysis: This is the difference between the total revenue accrued from cassava processing and the total variable cost incurred. It is a proxy for the profitability of food safety practices by cassava processors. It is expressed as:

$$Gross\ margin = Total\ revenue - Total\ variable\ cost$$

Where:

Total revenue is the returns from cassava processing and is calculated as the total output multiplied by the price per unit of produce (i.e., P * Q).

Total variable cost is the cost of all variable inputs used for processing cassava.

Net profit: Because gross margin analysis did not consider the fixed cost in its estimation, the study estimated the net profit of food safety practices among cassava processors. Net profit analysis considered the fixed cost in estimating the profit in food safety practice in cassava processing. It is used to ascertain the actual profit after deducting all costs of production. It is expressed as:

$$Net\ profit = Gross\ margin - Total\ fixed\ cost$$

or

$$Net\ profit = Total\ revenue - Total\ cost$$

Operating ratio: The operating ratio is directly related to the variable input usage in cassava processing. It measures the ratio of total variable costs to total revenue. The lower the ratio, the higher the profitability of the food safety practice among cassava processors and vice versa. It is expressed as:

$$Operating\ Ratio = \frac{Total\ Variable\ Cost}{Total\ Revenue}$$

The benefit-cost ratio: The benefit-cost ratio is defined as the total revenue from cassava processing divided by the total cost. It is expressed as:

$$Benefit\ cost\ ratio = \frac{Total\ revenue}{Total\ cost}$$

Return on capital invested: It measures the proportion derived as profit per unit of currency invested in food safety practices in cassava processing. It is expressed as:

$$Return\ on\ capital\ invested = \frac{Gross\ margin}{Total\ variable\ cost}$$

2.4.3 Likert-type scale rating technique

The Likert-type scale was developed in 1932 by Rensis Likert. It employs the principles of measuring attitude or opinion by asking people to respond to a series of statements about an issue, in terms of the level or extent of their agreement or disagreement with the statement. To examine the various safety practices among the cassava processors, a four-point Likert scale was used which was represented as never (1), rarely (2), sometimes (3), and always (4). The mean score of these four points Likert scale was 2.5. Therefore, any Likert mean score equal to or greater than 2.50 was considered a widely practised food safety measure among the cassava processors while those less than 2.50 were not widely used. To identify the challenges encountered by cassava processors in the food safety practice, a Likert-type scale was also used which was presented as: Extremely Severe (4), Very Severe (3), Moderately Severe (2), Not Severe (1). The mean score of these four points Likert scale was 2.50. Therefore, any Likert mean score equal to or greater than 2.5 was considered a severe constraint, and those less than 2.50 were not severe problems.

3. Results

3.1 Socio-economic characteristics of the cassava processors

The socioeconomic characteristics of the cassava processors were presented in Table 1. The results revealed that the majority (91.2%) of the cassava processors were females while only 8.3% were males. The majority (about 63%) were below 50 years, 25.8% were between 50 and 60 years of age, while only 10.8% were above 60 years of age. The average age of the cassava processors was 46.6 years. The majority (73.3%) of the cassava processors were married, 22.5% were widowed while only 4.2% were divorced. About 48% of the cassava processor had a household size between two and six persons, 44.2% had a household size between seven and ten persons, and 8.3% of them had a household size above ten persons. Their average household size was eight persons. Regarding the educational level of cassava processors, 31.7%, 28.3%, and 4.2% had primary education, secondary education, and tertiary education respectively while 35.8% had no formal education. The majority (85%) of the cassava processors had cassava processing as their primary occupation, while 9.17%, 3.3%, and 2.5% had farming, civil service, and artisan as their major occupations, respectively but practice cassava processing as a secondary occupation. The majority (52.5%) of the cassava processors had between 10 and 20 years of experience, 21.7% had 20 to 30 years of experience while 25.8% had less than ten years of experience. The mean years of experience was fifteen years. A larger proportion (55.83%) of cassava processors made a monthly income between ₦50,000 (USD 120.76) and ₦100,000 (USD 241.51), 21.67% of them had a monthly income between ₦100,000 (USD 241.51) and ₦150,000 (USD 362.27), 14.17% had above ₦150,000 monthly while 8.3% had between ₦20,000 (USD 48.30) and ₦50,000 (USD 120.76) monthly income. Their average monthly income was ₦72,666.67 (USD 175.50). The majori-

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ty (77.5%) of the processors did not belong to any co-operative association while only 22.5% were members of some cooperative associations and organizations.

3.2 Motivating factors for the use of safety practices

Table 2 shows the various motivating factors of food safety practices adoption by cassava processors. About 66% of cassava processors agreed with demand-driven as a motivating factor for the adoption of food safety practices. 60% opined that they adopt the food safety practice in cassava processing to make a profit. About 84% of the cassava process was motivated to adopt food safety practices due to the health concerns of their consumers. The majority (95.0%) agreed that improving efficiency was a motivating factor in practising food safety in cassava processing. About 56% opined that to reduced wastage was a motivating factor in practising food safety in cassava processing.

Table 1: Socioeconomic characteristics of the respondents

Variables	Category	Frequency	Percentage	Mean
Sex	Male	10	8.3	
	Female	110	91.7	
Age	30 - 40	37	30.8	46.67
	40 - 50	39	32.5	
	50 - 60	31	25.8	
	60 - 70	13	10.8	
Marital status	Married	88	73.3	
	Widowed	27	22.5	
	Divorced	5	4.2	
Household size	2 – 6	57	47.5	8.12
	7 - 10	53	44.2	
	10 - 12	10	8.3	
Highest education level	No formal	43	35.8	
	Primary	38	31.7	
	Secondary	34	28.3	
	Tertiary	5	4.2	
Primary occupation	Farming	11	9.17	
	Cassava Processing	102	85.0	
	Civil service	4	3.33	
	Artisan	3	2.5	
Cassava processing experience	<10	31	25.8	15.05
	10 - 20	63	52.5	
	20 - 30	26	21.7	
Average monthly income (₦)	20,000 - 50,000	10	8.3	72,666.67
	50,000 - 100,000	67	55.83	
	100,000 - 150,000	26	21.67	
	>150,000	17	14.17	
Member of the cooperative society	Yes	27	22.5	
	No	93	77.5	

Source: Research Survey, 2021.

Table 2: Motivation for use of safety practices in cassava processing

Motives of adoption	Yes	No
Demand driven	79 (65.8)	41 (34.2)
To make more profit	72 (60.0)	48 (40.0)
Health concern	101 (84.2)	19 (15.8)
Improve efficiency	114 (95.0)	6 (5.0)
Reduced wastage	67 (55.8)	53 (44.2)

Source: Research Survey, 2021

3.3 Assessment of cassava processors' knowledge of safety practices

Table 3 presents the cassava processors' knowledge of safety practices. Only 15.8% of the cassava processors opined that sorting of cassava was not necessary while the majority (90.8%) agreed that sorting was a good safety practice. The majority (97.5%) disagreed that peeling of cassava leads to the loss of edible tissues. Also, 95.8% of the cassava processors agreed that washing peeled cassava improves garri quality and reduces the health risk associated with unwashed cassava. In the same vein, 80.3% agreed that grating enhances the reduction of hydrogen cyanide in cassava. About 92% of the processors agreed that consuming cassava products that do not pass through fermentation is dangerous to human health. The majority (93.3%) were aware that frying cassava improves the quality and reduces poisonous substances in garri. All the cassava processors were aware that environmental hygiene helps to prevent contamination of cassava products. The majority of the processors (95%) agreed that cassava contains a poisonous substance (hydrogen cyanide). The majority (91.7%) agreed that cassava that does not pass through fermentation is dangerous to human health or for consumption. A larger proportion (64.2%) agreed that cyanide content varies with varieties of cassava.

3.4 Sources of information on food safety practices in Cassava Processing

Table 4 shows the various sources of information on food safety practices in cassava processing among the respondents. The majority (89.2%) of the respondents sourced food safety information through the radio. About 68% of the cassava processors sourced food safety information from their fellow processors who had undergone training or attended food safety programmes. About 56% sourced information from extension agents and 38.3% obtained food safety practice information through television programmes. Only 3.3% of them used the internet to source information on food safety practices. About 68% sourced food safety information from public sanitary officers.

3.5 Various safety practices by the cassava processors

Table 5 shows the various safety practices among cassava processors. The responses of the respondents were ranked using the Likert-type method. From the result, peeling, washing, grating, fermenting, and pressing were ranked first and always practised by all the processors. Sifting and peeling were ranked second among the safety practices in cassava processing. Storing of cassava products was also practised among the cassava processors. Since the mean value of all the listed safety practices was greater than 2.50, it suggests that all the listed safety practices were major safety practices the respondents have identified to use in their processing activities. This is an indication that cassava processors practised safety measures to a maximum in the course of their operations.

3.6 Profitability of food safety practices in cassava processing

Table 6 presents the profitability of food safety practices in cassava processing. The total revenue accrued from processing two tonnes of cassava to garri was ₦217,431.7 (USD 525.12). The total variable cost was ₦133,820.84 (USD 323.19). The cassava processing had a gross margin of ₦83,610.86 (USD 201.93) and a net profit of ₦81,052.33 (USD 195.75). The return on capital invested in food safety practices in cassava processing was 0.62. Food safety practices in cassava processing had an operating ratio of 0.61. The ben-

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Table 3: Assessment of processors' knowledge of safety practices

Cassava processors knowledge	Yes	No
It is not necessary to sort cassava tuber	19 (15.8)	101(84.2)
Sorting of cassava tuber is a good practice	109 (90.8)	11 (9.2)
Peeling of cassava reduces the edible tissues	3 (2.5)	117(97.5)
Washing of peeled cassava improves cassava products' quality	115 (95.8)	5 (4.2)
Grating of cassava enhances the reduction of cyanide in cassava	97 (80.3)	23 (19.2)
Frying improves the quality and reduces poisonous substances in garri	112 (93.3)	8 (6.7)
Keeping hygienic environmental prevent contamination	120(100.0)	0 (0.0)
Cassava contains a poisonous substance (cyanide)	114 (95.0)	6 (5.0)
Consuming cassava products that do not pass through fermentation is dangerous to human health	110 (91.7)	10 (8.3)
Content of cyanide varies with varieties of cassava	77 (64.2)	43 (35.8)

Source: Research Survey, 2021.

Table 4: Sources of information on safety practices in cassava processing

Source of information on cassava processing	Frequency	Percentage
Fellow processors	81	67.5
Extension agents	69	57.5
Internet	4	3.3
Radio	107	89.2
Television	46	38.3
Public sanitary officers	82	68.3

Source: Research survey, 2021.

Table 5: Food safety practices by cassava processors

Safety practices	Never	Rarely	Sometimes	Always	WS	MS	Rank
Peeling	0(0.0)	0 (0.0)	0 (0.0)	120(100.0)	480	4	1st
Washing	0(0.0)	0 (0.0)	0 (0.0)	120(100.0)	480	4	1st
Grating	0(0.0)	0 (0.0)	0 (0.0)	120(100.0)	480	4	1st
Fermentation	0(0.0)	0 (0.0)	0 (0.0)	120(100.0)	480	4	1st
Pressing	0(0.0)	0 (0.0)	0 (0.0)	120(100.0)	480	4	1st
Sifting	0(0.0)	0 (0.0)	6 (5.0)	114 (95.0)	474	3.95	2nd
Frying	0(0.0)	0 (0.0)	6 (5.0)	114 (95.0)	474	3.95	2nd
Storing	0(0.0)	0 (0.0)	31 (25.8)	89 (74.2)	449	3.74	3rd

Source: Research Survey, 2021.

efit-cost ratio in cassava processing was 1.52. These results show that food safety practices in cassava processing were profitable.

3.7 Perception of the processors on the risk involved in cassava processing

Table 7 shows the perceptions of cassava processors on the various risks involved in food safety practices in the processing of cassava. Fifty percent of the cassava processors agreed that raw cassava spoilage due to pest and disease was a risk in cassava processing while 50% disagreed. The majority of the processors

disagreed that an inadequate market for produce was a risk in cassava processing while 25.8% agreed that it is a risk. About 64.2% agreed that poor fermentation was a risk in cassava processing while 35.8% disagreed. Meanwhile, 20.8% agreed that a communal conflict was a risk in cassava processing while 79.2% disagreed. Ninety-five percent of the cassava processors agreed that cassava and its product's spoilage was due to inadequate storage facilities was a risk in cassava processing while only five percent disagreed with it.

Table 6: Profitability of food safety practices in cassava processing

Variables	Amount (in Naira) per 2 tonnes
Total Revenue (A)	217,431.7
Raw cassava	102,125.00
Water	450.83
Firewood	4,304.17
Transport	6,125.00
Labour	12,316.67
Grating and pressing	8,500
Total Variable Cost (B)	133,820.84
Rent	723.53
Knife	315
Sieving and frying material	1,520
Total Fixed Cost (C)	2,558.53
Total Cost (D = B + C)	136,379.37
Gross margin (E = A – B)	83,610.86
Net profit (F = E – C)	81,052.33
Benefit-cost ratio (G = A/D)	1.59
Return on capital invested (H = E/B)	0.62
Operating ratio (I = B/A)	0.61

(USD 1 = ₦414.06)

Source: Research Survey, 2021

Table 7: Perception of cassava processors on the risk involved

Risks involved	Yes	No
Spoiled cassava due to pest and diseases	60 (50.0)	60 (50.0)
Marketing risk	31 (25.8)	89 (74.2)
Poor fermentation	77 (64.2)	43 (35.8)
Communal conflict	25 (20.8)	95 (79.2)
Products spoilage due to inadequate storage facilities	114 (95.0)	6 (5.0)

Source: Research Survey, 2021

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3.8 Constraints to food safety practices in cassava processing

Table 8 shows the various constraints to food safety practices in cassava processing. The major or severe constraints faced in food safety practises were inadequate finance (Ẍ = 3.71), high cost of cassava roots (Ẍ = 3.55), the time-consuming nature of food safety practices (Ẍ = 3.43), poor access to clean water (Ẍ = 3.38), cumbersome nature of the safety practices in cassava processing (Ẍ = 3.38), fluctuation in market price (Ẍ = 3.27), lack of access to disposal facilities (Ẍ = 3.15), non-availability of modern processing facilities (Ẍ = 3.09), unable to meet demand volume (Ẍ= 3.03), weak institutional support for extension (Ẍ = 2.89), and branding of cassava products (Ẍ = 2.76). While lack of skilled labour (Ẍ = 2.47) and poor access to public education and information (Ẍ = 2.11) were not considered major constraints to food safety practices among cassava processors.

Table 8: Constraints to food safety practices in cassava processing

Constraints	ES	VS	MS	NS	WS	MS	Rank
Inadequate finance	85(70.8)	35(29.2)	0 (0.0)	0 (0.0)	445	3.71	1st
High cost of cassava roots	66(55.0)	54(45.0)	0 (0.0)	0 (0.0)	426	3.55	2nd
Time consuming nature of food safety	66(57.4)	49(42.6)	0 (0.0)	0 (0.0)	411	3.43	3rd
Poor access to clean water	62(51.2)	41(34.2)	17(14.2)	0 (0.0)	405	3.38	4th
Cumbersome nature of the safety practices	55(45.8)	55(45.8)	10(8.3)	0 (0.0)	405	3.38	4th
Fluctuation in market price	36(30.0)	80(66.7)	4 (3.3)	0 (0.0)	392	3.27	6th
Lack of access to disposal facilities	51(42.5)	36(30.0)	33(27.5)	0 (0.0)	378	3.15	7th
Lack of modern processing facilities	48(40.0)	35(29.2)	37(30.8)	0 (0.0)	371	3.09	8th
Inability to meet demand volume	41(34.2)	42(35.0)	37(30.8)	0 (0.0)	364	3.03	9th
Weak institutional support for extension	28(23.3)	51(42.5)	41(34.2)	0 (0.0)	347	2.89	10th
Inability to brand	20(16.7)	51(42.5)	49(40.8)	0 (0.0)	331	2.76	11th
Unavailability of skilled labour	6 (5.2)	55(47.8)	54(47.0)	0(0.0)	297	2.47	12th
Poor access to public education and information	0(0.0)	41(34.2)	51(42.5)	28(23.3)	253	2.11	13th

ES = extremely severe; VS = very severe; MS = moderately severe; NS = not severe; WS = weighted score; MS = mean score

Source: Research Survey, 2021

4. Discussion

Description of the socioeconomic characteristics of the cassava processors is important as it can influence the processors' decision to practise food safety in cassava processing and the profitability of the venture. The majority of the cassava processors were females which imply that females dominate the cassava processing ventures. This is because the males engage in on-farm activities while females engaged in the processing of crops in most rural areas. This finding was in line with Alamu et al. (2019), and Kolawole et al. (2012) who reported that women carried out most cassava processing activities. The average age (46.6 years) of the cassava processors suggests a population that was still in their economic active age where they can practise cassava processing efficiently and in a safe manner. The majority of the cassava processors were married while the minority were widowed and divorced. Previous studies had also shown that rural dwellers were married (Mukaila et al., 2021a; Obetta et al., 2020). This suggests that cassava processing is a means of catering for the households in the study area. Their average household size of eight persons implies a relatively large household size among the cassava processor. Households determined the availability of family labour in rural households which could enhance their productivity (Mukaila et al., 2022). Thus, the cassava processor could be said to have cheap family labour which could assist them in processing cassava.

The majority of the cassava processors had some level of education which could enhance their decision-making process. Akanbi et al. (2020) stated that the level of education enhanced farmers' decision-making process. Farmers' high educational level enhanced their access to and use of information on new technology (Mwang & Kariuki, 2015), and influenced their thoughts and attitudes toward the benefits associated with innovation or new technology (Uematsu & Mishra, 2010; Waller et al., 1998). The majority of the cassava processors had cassava processing as their primary occupation, which suggests that the study targeted the right population and that cassava processing plays a significant role in people's wellbeing. The mean years of cassava processing experience of fifteen years suggest a population with a high level of experience in cassava processing. This is an indication of technical know-how. This is because people's understanding of a business increase as their years of experience increase (Mukaila et al., 2021b).

The average monthly income of cassava processors was ₦72,666.67 (USD 175.50). This implies that cassava processing plays a vital role in their economic status. The majority of the processors did not belong to any cooperative association or organizations. The implication of this is that the cassava processing population may not be financial inclusive as they may not be able to take full advantage of economies of scale inherent in membership of cooperatives. This is because groups enable farmers to access adequate credit and market information (Adong et al., 2012; Falola et al., 2022), enjoy economic benefits (Wossen et al., 2013) and can join resources to try modern processing facilities. Also, group social capital in rural areas is used for mutual benefits (Alele et al., 2013).

Regarding the various motivating factors for food safety practices adoption by cassava processors, the majority of cassava processors were motivated to engage in food safety practices due to demand-driven for well-processed cassava products. Globally due to health concerns, consumers are now willing to pay for safe food with no foodborne related diseases (Liu et al., 2020; Yin et al, 2020; Vajda et al, 2020; Louw, 2020; Nayga, 2006). Because many consumers are now concerned about the safety of the food they eat, they go for a well-prepared cassava product that will not affect their health status. Nigerian garri consumers taste the product to know if it is well fermented and prepared. Well-processed cassava products had a high demand from consumers. A larger proportion of cassava processors adopt the food safety practice in cassava processing to make a higher profit. This could be due to the high demand for well-prepared cassava products which, in turn, attracts a better price. In the same vein, the majority of the cassava process was motivated to adopt food safety practices due to the health concerns of their consumers. This suggests that they were aware of the negative impact of poorly prepared food (cassava). The majority agreed that improving efficiency and to reduced wastage were also motivating factors for practising food safety in cassava processing.

Regarding the cassava processors' knowledge of safety practices, the majority of the cassava processors

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opined that sorting of cassava was necessary and good practice to maintain high-quality cassava products. Sorting of cassava tubers allows the processors to remove the bad or spoilt cassava to avoid food poison and affecting consumers' health. The majority of the processors disagreed that the peeling of cassava leads to the loss of edible tissues. This implies that they were aware of the importance of peeling cassava before processing. The cassava processors were aware that washing peeled cassava improves garri quality and reduces the health risk associated with unwashed cassava. This could be because unwashed peeled cassava might harbour pathogenic materials. In the same vein, they agreed that grating enhances the reduction of hydrogen cyanide in cassava. This is because the grating of cassava allows easy removal of hydrogen cyanides as the cassava will be mashed. In the same vein, the processors were aware that cassava that does not pass through fermentation is dangerous to human health or for consumption. This implies that the cassava processors were aware of the health risk associated with consuming cyanides. The majority of the processors were aware that frying cassava improves the quality and reduces poisonous substances in garri. All the cassava processors were aware that environmental hygiene helps to prevent contamination of cassava products. The majority of the processors were aware that cassava contains a poisonous substance (hydrogen cyanide). A larger proportion was aware that cyanide content varies with varieties of cassava. It is a usual practice among the local processors to break a raw cassava tuber to see the inside and sometimes taste it to check if the cassava is sweet or bitter. They were aware that bitter cassava contains a high level of hydrogen cyanide than sweet cassava. These results are indications that the majority of the processors had adept knowledge of various safety and precaution practices among cassava processors. Adeoye et al. (2019) reported a similar finding that the majority of the cassava processors were aware that sorting, washing, grating, pressing and fermentation are good safety practices.

Regarding the various sources of information on food safety practices in cassava processing among the respondents. The majority of the cassava processors sourced information through the radio. The government organised some food safety programmes on the radio where they enlightened the people on how to prepare and process food in a hygienic way to avoid foodborne diseases. Cassava processors who had undergone training or attended food safety programmes disseminate information on food safety information to other processors. Thus, well-trained processors served as means of food safety practises information to other cassava processors. More than half of the cassava processors sourced food safety practice information from extension agents who visited their processing centres to educate them on food safety practices. A smaller proportion of the cassava processors obtained food safety practice information through television programmes. The internet as a source of food safety information was used by a few of the cassava processors who had a high level of education. A larger proportion of cassava processors sourced food safety information from public sanitary officers who enlightened them on the importance of maintaining a hygienic environment, the use of clean water in the processing activities, fermentation, and proper disposal of waste products. These are indications that cassava processors are not lacking information as they possess various media through which they can obtain food safety information. Thomas and Philips (2015) reported a similar result that cassava processors sourced food safety information from fellow processors and public sanitary officers.

Regarding the various safety practices among the cassava processors, all the cassava processors peeled the cassava tuber to remove the outer part. After peeling the cassava, all the cassava processors washed the peeled cassava to remove all dirt from the cassava to avoid sand or other unwanted dirt. After washing, all the cassava processors proceeded to grate the cassava to a fine texture. All of them fermented the grated cassava to lower the effect of hydrogen cyanide present in cassava and for a better taste as most consumers prefer well-fermented cassava (garri) in Nigeria. After fermentation, all the cassava processors pressed the cassava to remove hydrogen cyanide and the liquid in the cassava. The majority of the cassava processors sifted the cassava after pressing. The few cassava processors that did not sift processed the cassava into cassava flour locally called elubo lafun (a local food prepare to make amala. A food widely consumed by the Yoruba tribe in Nigeria). The majority of the cassava processors fried the cassava to make garri. This further removes the remaining hydrogen cyanide and

moisture content present in it. It also increases the lifespan of garri during storage. The few that did not fry it sundry it to make cassava flour (elubo lafun).

This also removes the moisture content and hydrogen cyanides present in it and further elongate the lifespan of elubo lafun. Oghenechavwuko et al. (2013) also reported that oven drying or sun drying of cassava is to reduce post-harvest loss and improves its shelf life. The majority of the cassava processors stored the cassava products for a short period after production. The short storage period was because they did not have modern storage facilities. Only 25.8% sold cassava products immediately after production. These results imply that the cassava processors widely practised food safety in cassava processing.

Based on the profitability of food safety practices in cassava processing, the cassava processing had a gross margin of ₦83,610.86 and a net profit of ₦81,052.33 from total revenue of ₦217,431.7 accrued from processing two tonnes of cassava. The return on capital invested in cassava processing was 0.62. This implies that for every ₦1 invested in cassava processing, ₦0.62 was earned as a return to cassava processing. Thus, cassava processing had a relatively high investment return. The operating ratio of 0.61 in cassava processing implies that sixty-one percent of the gross revenue was used as operating cost in cassava processing. The positive benefit-cost ratio (1.52) in cassava processing implies a positive benefit to cassava processing. These results imply that food safety practices in cassava processing were profitable and productive. Thus, apart from the safety concern and benefits of cassava processing, it was economical, productive, and profitable.

Regarding the perceptions of cassava processors on the various risks involved in the processing of cassava, half of the cassava processors perceived that raw cassava spoilage due to pests and disease was a risk in cassava processing. This is because infected cassava tuber reduced the quality and quantity of cassava products' output and consequently the profitability of the enterprise. It further affected the safety of cassava products for consumption. The majority of the processors did not perceive an inadequate market for cassava products as a risk in cassava processing. This could be a result of the availability of a market for well-processed cassava. A larger proportion perceived that poor fermentation was a risk in cassava processing. This is because poor fermented cassava produce will attract low demand and price as consumers prefer well-fermented cassava products (garri). This makes the processors undertake and participate in the food safety practices in cassava processing. The majority of the cassava processors agreed that communal conflict was not a risk in cassava processing. This suggests a peaceful environment for cassava processing. The majority of the cassava processors agreed that spoilage of cassava and its products due to inadequate storage facilities was a risk in cassava processing. These results indicate that pests and diseases, poor fermentation, and inadequate storage facilities were the highly considered risk among the cassava processor while marketing and communal clashes were not major risks.

Regarding the various constraints to food safety practices in cassava processing, inadequate finance was a major constraint to food safety practices in cassava processing and was ranked first. This could be due to their inability to access credit among them. The processors disclosed that it was difficult for them to get financial support in form of credit, especially from commercial banks. This could limit their production to a small scale (Falola et al., 2022). The high cost of cassava roots was also a major challenge to cassava processing. The COVID-19 pandemic which affected the 2020 planting season increased the price of cassava tuber. One tonne of cassava which was sold for about ₦30,000 (USD 72.45) in 2019 was sold for ₦80,000 (USD 193.21) to ₦130,000 (USD 313.96) in 2020/2021. This affected the processors as their capital was not enough to purchase a large volume of cassava. This makes most processors to processed two to three tonnes per month. The time-consuming nature of food safety practices was considered a severe constraint by the processors. They spent at least one week for each processing cycle to maintain food safety. Poor access to clean water was also a severe constraint to food safety practices in cassava processing. This could be because water is a major input in cassava processing. They need clean water to wash the cassava after peeling and to clean the processing materials and environments. The cumbersome nature of the safety practices in cassava processing was also a major constraint as it involves several methods to produce a product free from foodborne diseases and safe for human consumption. Fluctuation in market price also

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affected their processing activities as cassava tuber prices are highly volatile which consequently affected their plan and decision-making process.

Lack of access to disposal facilities was also a major constraint to the processors. Before food safety practices, they dump their waste very close to the processing centres. But as they practice food safety in cassava processing, they have to move their waste to a far place as they were unable to access modern disposal facilities. The non-availability of modern processing facilities was a severe problem for food safety practices among cassava processors. Due to inadequate financial support, the processors could not afford to get modern processing facilities such as modern fryers, peelers, graters, pressers, washers, and extractors which could have enhanced their food safety practices and reduced their stress and time. The processors who practised food safety were unable to meet demand volume due to low production as a result of poor financing and a lack of modern processing facilities. Nigeria alone has over 200 million consumers of cassava products who are ready and willing to purchase well-processed cassava products. Weak institutional support for the extension also hinders food safety practices among cassava processors. Extension contacts with cassava processors were low due to weak support. Branding of cassava products, especially garri, was a constraint to food safety practices among the cassava processors. The processors lack the technical skills to brand their products to meet export demand.

This also hinders their ability to get NAFDAC registration numbers and SON accreditation. Lack of skilled labour was not considered a major constraint to food safety practices among cassava processors. This could be because the processors did not use modern equipment that requires technical know out and because they supervised the activities of their workers. Poor access to public education and information was also not a constraint to food safety practice. This could be because they had access to several sources of food safety information.

5. Conclusion

This study investigated the economics of food safety practices among cassava processors. The study revealed that the majority of the cassava processors were females who were married, still in their economically active age, well experienced and employed food safety practices in processing cassava. Their sources of food safety information for cassava processing were radio, public sanitation officers, extension agents, colleagues, television and the internet. The processors made use of all safety practices (such as peeling, washing, grating, fermenting, pressing, sifting, frying or drying and sometimes storing) involved in cassava processing. The processors perceived cassava pests and diseases, poor fermentation and inadequate storage as the major risk involved in cassava processing while marketing risk and communal conflict were not major risks. The motivational factors to embark on food safety practices by the cassava processors were high demand for safe cassava products, high profit, health concerns, to improve the efficiency of production and to reduce wastage of the products. The food safety practices were profitable with a relatively high return on capital invested, low operating ratio, and a positive benefit-cost ratio. This shows that apart from the food safety concern, food safety practices in cassava processing were economical, productive and profitable. Despite the profitability of the ventures, the cassava processors faced some challenges. The major constraints faced in food safety practices in cassava processing were inadequate finance, time-consuming nature of food safety practices, poor access to clean water, cumbersome nature of the safety practices in cassava processing, fluctuation in market price, lack of access to disposal facilities, non-availability of modern processing facilities, unable to meet demand volume, and weak institutional support for the extension agents.

To enhance food safety practices among cassava processors, sufficient extension services should be extended to the processors to educate and encourage the processors to continue and improve the practice of food safety in cassava processing. Also, the use of improved varieties of cassava low in cyanide content should be encouraged among the processors to avoid food poisoning. This can be achieved through the distribution of low or no-cyanide cassava seeds by the government and research institutes to the farmers who sell cassava tubers to the processors. There should be an effective institution established by the government or processors groups or associations to standardize the products from cassava processing

and grade the products according to their safety of consumption. This would further assist and motivate the processors to brand their products. Furthermore, provision of credit facilities to the processors towards ensuring large-scale processing will have positive effects. The provision of automated modern processing facilities by the government is needed to reduce the stress experience and time during cassava processing. These would ensure food safety practices among cassava processors, ensure efficiency in the processing activities and enhance the enterprise's profitability.

Conflict of Interest

The authors declare that there is no conflict of interest.

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